Global Warming: Forecasts by Scientists versus Scientific Forecasts

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Conclusions

Predictions of global warming are forecasts by scientists – not scientific forecasts.

We have been unable to find a scientific forecast to support global warming.

Background

- Professor at the Wharton School since 1968
- A founder of:
  - *Journal of Forecasting*
  - *International Journal of Forecasting*
  - forecastingprinciples.com
- Author of:
  - *Long-range Forecasting* (1978; 1985) and over 70 papers on forecasting
- Editor of
  - *Principles of Forecasting* (handbook)
- Details and full-text of papers at jscottarmstrong.com

Our contribution

Green & Armstrong, "Global Warming: Forecasts by Scientists versus Scientific Forecasts" forthcoming in *Energy and Environment**

- We are experts on forecasting methods, not climate
- Neither of us has received funding for our research on climate forecasting
- We have received sponsorship from the International Institute of Forecasters for publicpolicyforecasting.com and for theclimatebet.com

*available at publicpolicyforecasting.com

Global climate does change—but can we forecast the changes?

"A trend is a trend,
But the question is, will it bend?
Will it alter is course
Through some unforeseen force
And come to a premature end?"

Alec Cairncross 1969

Scientific forecasts

- "Forecasts derived using evidence-based methods"
- Research over half a century has produced many evidence-based findings
- Summarized as principles at forecastingprinciples.com, a free and easily accessible site, and in *Principles of Forecasting* (Armstrong 2001)

Examples of Principles

- Experts' unaided judgments have little value in forecasting over time
- Agreement among experts is *weakly* related to accuracy—but highly related to confidence.
- Complex models harm forecast accuracy
- Uncertainty calls for conservatism

The Forecasting Problem

For policy recommendations based on global warming, forecasts must be accurate for each of the following areas:

1. **Long-term temperature change**

2. Effects of temperature changes

3. Effects of feasible policy changes

Forecasts of global temperature change

- Green & Armstrong (2007) looked primarily at forecasts of medium to long-term temperature change.

Forecasts from climate modelers

- Some climate modelers claim that their models do not make forecasts

- However, climate modelers do make forecasts:

  The word "forecast" and its derivatives occurred 37 times, and "predict" and its derivatives occurred 90 times in the body of Chapter 8 of the 2007 IPCC report.

- They use models to express their judgments—what goes in and what comes out. Thus, they make "expert forecasts."

Other scientists see climate models as expert opinions written in mathematics

- Pilkey & Pilkey-Jarvis (2007) concluded long-term climate forecasts were based only on the opinions of the scientists expressed in complex mathematical terms—and use this quotation:
  - "Today's scientists have substituted mathematics for experiments, and they wander off through equation after equation and eventually build a structure which has no relation to reality."
  - (Nikola Telsa, inventor and electrical engineer, 1934).

Are Experts' Forecasts of Global Climate Useful?

- Poor forecasts easy to find

  1924: MacMillan reports signs of new ice age

  1974: A major cooling widely considered to be inevitable

- Seer-sucker theory proposed in 1978
  - No matter how much evidence exists that seers do not exist, seers will find suckers.
- Tetlock (2005) found support for this theory with evaluation of 82,000 forecasts over 20 years.

Prior Reviews of Climate Forecasting

- 1985: Climate scientists ignored judgmental forecasting principles. Forecasts then were based on expert opinion (Delphi) studies.

- 2006: *Stern Review* made no reference to scientific forecasting

** No prior reviews of forecasting methodology for climate models

Use of scientific literature

- Google searches in April 2007 revealed no citations of scientific literature on forecasting in global warming literature

Identifying key papers on climate change

Sent requests to 240 climate experts (70% were IPCC authors or reviewers),

> "We want to know which forecasts people regard as the most credible and how those forecasts were derived…
>
> – In your opinion, which scientific article is the source of the most credible forecasts of global average temperatures over the rest of this century?"

51 people sent responses, of which

42 included references, of which

30 referred to latest IPCC report

Scientific Literature in IPCC Chapter 8

Of the roughly 650 references cited in IPCC 8, none had any obvious relationship to evidence-based forecasting methods

Forecasting audit standards

1. All elements of the forecasting process are examined
2. Each principle supported by evidence
3. Ratings against each principle assessed independently by two or more people
4. Ratings identify errors of omission and of commission
5. Full disclosure of the ratings

Audit of IPCC Chapter 8

- Of the 140 principles in the *Forecasting Audit*, we judged 127 relevant
- Each author rated the forecasting methods independently, then we resolved differences
- We were able to rate 89 principles of which **72 principles were violated**

Some important violations

1.4	Use only methods that are better than a naïve model
7.1	Use simple forecasting methods
9.3	Do not use fit
13.26	Test on out-of-sample data

Full disclosure & open peer review

- Our audit is fully-disclosed at publicpolicyforecasting.com
- Others invited to apply the *Forecasting Audit* to Ch. 8—or to another climate forecasting paper and publish on the site.
- We welcome commentary and open peer review on our paper.

No scientific forecast to date

- Climate is complex and poorly understood.
- Much uncertainty
- Key (IPPC) forecasts violate important principles.

In such conditions, climate models are expected to be inferior to the simple naïve model, which assumes complete ignorance.

Is the naïve model best?

- Possibly not.
- Based on prior research, I would recommend testing such methods as

  - Extrapolation of (very) long-term trends
  - Naïve model with drift
  - Rule-based forecasting
  - Simple models with well-founded causal relationships (assuming these can be identified & causal variables can be forecasted)
  - Combining forecasts from different methods

The Global Warming Challenge

- Claims have been made that the Earth will warm rapidly.
- These are not based on scientific forecasting methods. Thus, the challenge:

Predict global mean temp over 10 years.

- Al Gore selects any current climate model
- Scott Armstrong will assume *no change*

Each deposits $10,000 in a trust fund in Dec. 2007. Value to winner's charity in 2018.

Purpose of the Challenge

- While I expect the naïve method to be more accurate, winning is not what's important.

- A Gore/Armstrong collaboration can yield benefits for public policy by fostering the use of science in forecasting for public policy

  with:

  - evidence-based forecasting principles,
  - comparative tests among a variety of forecasting methods (going beyond the naïve method),
  - proper validation tests (going beyond the simple test in the challenge)

Updates on challenge provided at…

theclimatebet.com

Along with latest version of paper

A failure in any of the three problems negates public policy recommendations

1. Long-term temperature change *

2. Effects of changes

3. Effects of feasible policy changes

Forecasts of global warming may be harmful if accepted

- Misallocation of resources away from uses which would do more to make peoples lives better
- Rejection of policy options due to false premises:
  - Evaluate policy recommendations on their merits (e.g., energy taxes)—assessing both intended and unintended consequences

Standards for publicpolicyforecasting.com

- Researchers can publish audits.
- Content
  - Full or partial evidence-based audits
  - Full disclosure of the audit
- Moderated to avoid
  - "advertisements"
  - ad hominem arguments
- Attributed contributions with contact, bio, and potential bias.

Public policy should be based on scientific forecasting

Forecasts from expert judgment are of no value

Forecasting should be judged against evidence-based principles—which are easy to find and freely available

Conclusions

- We have been unable to find a single scientific forecast to support global warming
- Forecasts by climate experts are of no value.
- Climate will change in the future, but…
  - To date, the most sensible forecast is for "no change" because we are not sure of direction or magnitude
  - Scientific forecasting methods can be tested to see if any are more accurate than the "no change" forecast.